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Declaration

I, Megumi Odawara, a translator of Fukuyama Sangyo Honyaku Center, Ltd., of 16-3, 2-chome, Nogami-cho, Fukuyama, Japan, do solemnly and sincerely declare that I understand well both the Japanese and English languages and that the attached document in English is a full and faithful translation, of the copy of Japanese Patent Application No. 2000-022747 filed on January 31, 2000.

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[TITLE OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] BARRIER OPENING AND CLOSING DEVICE FOR LENS BARREL

[WHAT IS CLAIMED IS;]

[Claim 1] A barrier opening and closing device for a lens barrel, which is provided on a lens barrel that is movable to a photographing position and a housing position at which photographing is not carried out, and closes the photographing aperture ahead of the photographing lens by barriers when the lens barrel is at the housing position, and opens the barriers when the lens barrel is at the photographing position, comprising:

a barrier drive collar for opening and closing said barriers by forward and backward rotations;

drive collar pressing means for pressing this barrier drive collar forward or in reverse;

a rotary collar which at least rotates when the lens barrel moves between the photographing position and housing position; and

a rotation providing surface and a rotation transmitting surface which are formed at the barrier drive collar and rotary collar in the axial direction and engages with each other when the lens barrel moves to either the photographing position or

housing position, and forcibly rotates the barrier drive collar together with the rotary collar in a direction opposite to said drive collar pressing means.

[Claim 2] The barrier opening and closing device for a lens barrel according to Claim 1, wherein said rotation providing surface of the barrier drive collar is formed into a protrusion extending in the axial direction, and said rotation transmitting surface of said rotary collar is formed into a boundary surface of a concavity into which the protrusion formed in the axial direction can intrude.

[Claim 3] The barrier opening and closing device for a lens barrel according to Claim 1 or 2, wherein said barrier drive collar and said rotary collar change an interval between them in the optical axis direction while changing their rotation phases; and

when the rotary collar is at a position, at which the rotary collar does not forcibly rotate the barrier drive collar, of either the photographing position or housing position, the barrier drive collar and rotary collar are separated from each other in the optical axis direction so as to prevent the rotation providing surface of said rotary collar and the rotation transmitting surface of said barrier drive collar from overlapping each other in the optical axis direction.

[Claim 4] The barrier opening and closing device for a lens barrel according to Claim 3, further comprising:

a rectilinear cylinder which is positioned outside said rotary collar and rectilinearly guided in the optical axis direction, and rotatably supports said barrier drive collar on the end face;

guide pins projected inward in a diameter direction of the rectilinear cylinder; and

advancing and retreating guide grooves which are formed at the outer circumferential surface of said rotary collar, and engage with the guide pins to advance and retreat said rectilinear cylinder in the optical axis direction by rotating said rotary collar.

[Claim 5] The barrier opening and closing device for a lens barrel according to any one of Claims 1 through 4, further comprising barrier pressing means whose forces are weaker than those of said drive collar pressing means and press said barriers to either the closing positions or the opening positions opposite to the pressing directions of said drive collar pressing means, wherein

when the barrier drive collar is rotated by the rotary collar against the drive collar pressing means, the barriers are moved by the barrier pressing means.

[Claim 6] A barrier opening and closing device for a lens barrel, comprising:

barriers for opening and closing a photographing aperture ahead of the photographing lens;

a rotary collar which at least rotates when the lens barrel moves between a photographing position and a housing position at which photographing is not carried out;

a barrier drive collar which is rotatably supported on a rectilinear cylinder whose circumferential rotation is restricted, and opens and closes the barriers by forward and backward rotations;

opening direction pressing means for rotatively pressing the barrier drive collar to a position for opening the barrier; and

a rotation providing surface and a rotation transmitting surface which are formed on the barrier drive collar and rotary collar, respectively, and are engageable with and disengageable from each other, wherein

when the lens barrel moves from the photographing position to the housing position, the rotation providing surface of said rotary collar and the rotation transmitting surface of said barrier drive collar engage with each other, and the barrier drive collar is forcibly rotated in a direction for closing

the barriers against said opening direction pressing means.

[Claim 7] The barrier opening and closing device for a lens barrel according to Claim 6, wherein

the barrier drive collar has pressing portions that are engageable with and disengageable from the barriers,

and said barrier opening and closing device for a lens barrel further comprises closing direction pressing means for pressing the barriers to the closing positions, the pressing forces of which are weaker than those of said opening direction pressing means;

when the lens barrel is at the photographing position, the pressing portions of the barrier drive collar held at a position for opening the barriers by said opening direction pressing means press the barriers whereby the barriers are opened; and

when the lens barrel moves from the photographing position to the housing position, by forcibly rotating the barrier drive collar against the opening direction pressing means by said rotary collar, the pressing portions of the barrier drive collar withdraw from the engaging positions with the barriers, and the barriers are closed by said closing direction pressing means.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Field of the Art]

The present invention relates to a barrier opening and closing device for a lens barrel.

[0002]

[Prior Arts and Problems Thereof]

There is a lens barrel which has a housing position at which photographing is not carried out in addition to a photographing position, and opens and closes the lens barriers by using the force of barrel movement between the photographing position and housing position. In a generally known conventional barrier opening and closing device, a barrier drive collar which is rotatable in the circumferential direction is spring-pressed against the rotation end for opening the barrier, and when the lens barrel moves from the photographing position to the housing position, a separate movable member comprising the lens barrel engages with the barrier drive collar to forcibly rotate the rotation end against the spring pressing forces whereby the barriers are closed. When the lens barrel moves from the housing position to the photographing position, the forcibly moving force of the separate movable member applied to the barrier drive collar is released, and the barrier drive collar rotates to the pressed rotation end, whereby the barriers are opened. Furthermore, a barrier opening and closing device is

known which is constructed so that the barriers themselves are pressed with springs in the closing directions, and when the barrier drive collar is forcibly rotated by the abovementioned separate movable member, the barriers are closed by these closing springs. In this case, the closing springs pressing the barriers themselves are set so as to have pressing forces that are weaker than those of the springs pressing the barrier drive collar in the barrier opening direction.

[0003]

In such a barrier opening and closing device, the greater the pressing load of the spring that is pressing the barrier drive collar or the barrier, the more securely the barriers are opened and closed. On the other hand, the forces for driving the barriers against the pressing means should be originally used for extending and housing the lens barrel, so that an excessive load of the pressing means influences extending and housing performance of the lens barrel.

[0004]

The difference between the photographing position and the housing position of the lens barrel is, plainly speaking, a change in position in the axial position of the lens barrel, so that to rotate the barrier drive collar, it is considered that the moving force of the moving member toward the axial

direction is converted into a rotary force in the circumferential direction. For example, in a conventional barrier opening and closing device, tapered surfaces which are inclined with respect to the optical axis direction are formed on the rectilinear cylinder which is rectilinearly guided in the optical axis direction and the barrier drive collar, respectively, and by engagement between these tapered surfaces, a component force in the circumferential direction from the optical axis direction moving force of the rectilinear cylinder rotates the barrier drive collar. However, conversion of the moving force in the optical axis direction into a forcibly moving force in the circumferential direction causes a great force loss. As mentioned above, to securely operate the lens barrier, it is desirable that the load of the pressing means is as great as possible, however, in a condition with a great force loss in the power transmitting process from the movable member to the barrier drive collar of the lens barrel, there is a possibility that the lens barrel cannot cope with the load of the pressing means and the extending and housing performance of the lens barrel lowers. In order to prevent this, if the lens barrel moving force is increased, an excessive load is applied to the lens barrel drive motor.

[0005]

[Object of the Invention]

The present invention has been made in view of the abovementioned problems, and an object thereof is to provide a barrier opening and closing device which can securely operate lens barriers without losing operation performance of the lens barrel.

[0006]

[Outline of the Invention]

A barrier opening and closing device according to the invention, which is provided on a lens barrel that is movable between a photographing position and a housing position at which photographing is not carried out, and closes a photographing aperture ahead of the photographing lens by barriers when the lens barrel is at the housing position, and opens the barriers when the lens barrel is at the photographing position, is characterized by comprising: a barrier drive collar which opens and closes the barriers by forward and backward rotations, a drive collar pressing means for pressing this barrier drive collar forward or in reverse, a rotary collar which at least rotates when the lens barrel moves between the photographing position and housing position, and a rotation providing surface and a rotation transmitting surface which are formed on the barrier drive collar and rotary collar in

the axial direction, and forcibly rotate the barrier drive collar in a direction against the drive collar pressing means together with the rotary collar by engaging with each other when the lens barrel moves toward either the photographing position or the housing position. By this barrier opening and closing device, since the barrier drive collar is driven by the rotary force of the rotary collar which rotates in the circumferential direction in the same manner as the barrier drive collar, the loss in force during power transmission can be minimized. Therefore, moving performance of the lens barrel itself can be prevented from being lost while maintaining high barrier operation performance by increasing the load of the pressing means.

[0007]

In this barrier driving device, the rotation providing surface of the barrier drive collar is formed to be a protrusion protruding in the axial direction, the rotation transmitting surface of the rotary ring is formed as a boundary surface of a concavity into which this protrusion in the axial direction can intrude.

[0008]

Furthermore, when the lens barrel moves between the photographing position and housing position, the barrier drive

collar and rotary collar change the interval in the optical axis direction while changing their rotation phases, and when the lens barrel is at one position at which the rotary collar does not forcibly rotate the barrier drive collar of the photographing position and housing position, it is preferable that the barrier drive collar and rotary collar are separated in the optical axis direction so as to prevent said rotation providing surface of the rotary collar and said rotation transmitting surface of the barrier drive collar from overlapping in the optical axis direction. Thus, as a construction for contacting and separating the barrier drive collar and rotary collar, for example, a construction is preferable which comprises a rectilinear cylinder which is positioned outside the rotary collar and rectilinearly guided in the optical axis direction, and rotatably supports the barrier drive collar on the end face, a guide pin projecting inwardly in a diameter direction of the rectilinear cylinder, and an advancing and retreating guide groove which is formed at the outer circumferential surface of the rotary collar, and advances and retreats the rectilinear cylinder in the optical axis direction in response to rotation of said rotary collar by engaging with this guide pin.

[0009]

Furthermore, in the abovementioned barrier opening and closing device, it is preferable that barrier pressing means the pressing forces of which are weaker than those of the drive collar pressing means are provided so that, when the barrier drive collar is rotated by the rotary collar against the drive collar pressing means, the barriers are moved by the barrier pressing means.

[0010]

Furthermore, a barrier opening and closing device for a lens barrel according to the invention is characterized by comprising: barriers for opening and closing the photographing aperture ahead of the photographing lens; a rotary collar which at least rotates when a lens barrel moves between a photographing position and a housing position at which photographing is not carried out; a barrier drive collar which is rotatably supported on a rectilinear cylinder whose circumferential rotation is restricted, and opens and closes the barriers by forward and backward rotations; opening direction pressing means for rotatively pressing this barrier drive collar toward a position for opening the barrier; and a rotation providing surface and a rotation transmitting surface which are formed in the axial direction on the barrier drive collar and rotary collar, respectively, so as to be

engageable with and disengageable from each other, wherein, when the lens barrel moves from the photographing position to the housing position, the rotation providing surface of the rotary collar which rotates and the rotation transmitting surface of the barrier drive collar engage with each other, whereby the barrier drive collar is forcibly rotated in a direction for closing the barriers against the opening direction pressing means.

[0011]

The barrier opening and closing device thus constructed is preferably constructed so that the barrier drive collar has pressing portions which are engageable with and disengageable from the barriers, and said barrier opening and closing device further comprises closing direction pressing means for pressing the barriers to the closing positions, the pressing forces of which are weaker than those of the opening direction pressing means, and when the lens barrel is at the photographing position, the pressing portions of the barrier drive collar held at a position for opening the barriers by means of the opening direction pressing means press the barriers, whereby the barriers are opened, and when the lens barrel moves from the photographing position to the housing position, the barrier drive collar is forcibly rotated against the opening direction

pressing means by the rotary collar, whereby the pressing portions of the barrier drive collar withdraw from the engaging positions with the barriers and the barriers are closed by the closing direction pressing means.

[0012]

[Preferred Embodiments of the Invention]

The present embodiment is obtained by applying the present invention to a digital camera zoom lens. The entire structure will be described first, and the features of the present invention will be described later.

[0013]

[Description of the entire lens barrel of the present embodiment]

The construction of the zoom lens barrel of the present embodiment will be described with reference to Fig. 1 and Fig. 2. In the description below, the parenthesized large letter (F) following a numeral next to a component name indicates that the component is fixed, and the parenthesized large letter (L) following a numeral next to a component name indicates that the component rectilinearly moves in the optical axis direction, and the parenthesized large letters (RL) following a numeral next to a component name indicate that the component moves in the optical axis direction while rotating.

[0014]

The lens composition of this embodiment is composed of, in order from the objective side, a first lens group L1 (L), a second lens group L2 (L), and a third lens group L3 (L), and zooming is carried out by moving the first lens group L1 and second lens group L2 in the optical axis direction along a predetermined locus while changing the interval between them. The third lens group L3 functions as a focusing lens regardless of the positions of the first lens group L1 and second lens group L2, and this lens system is a so-called rear-focusing zoom lens system.

[0015]

To housing 10 (F) to be fixed to a camera body (or to form a part of the camera body), a fixed collar 11 (F) is fixed. The fixed collar 11 has a miniature male screw 11a on the outer circumferential surface, and has a female helicoid 11b on the inner circumferential surface and rectilinear guide grooves 11c which are in parallel to the optical axis and formed by notching a part of this female helicoid 11b. The rectilinear guide grooves 11c are formed in threes at intervals of 120 degrees.

[0016]

The housing 10 is, as shown in Fig. 2, provided with CCD

inserting window 10a, filter fixing portion 10b, and focusing lens group moving guide 10c. CCD 12a fixed to the substrate 12 faces the CCD inserting window 10a, and to filter fixing portion 10b, a filter 10d such as a low-pass filter is fixed. On the focusing lens group moving guide 10c, a third lens group L3 is supported in a movable manner in the optical axis direction, and in accordance with the direction of rotation and rotation angle (amount) of a feed screw 10e, the moving position of the third lens group L3 is determined. The rotation angle of the feed screw 10e is pulse-controlled by a pulse motor (encoder).

[0017]

A rotary collar 13 (RL) is positioned outside the fixed collar 11, and a female screw 13a formed at the inner circumferential surface of this rotary collar 13 screw-fits the male screw 11a of the fixed collar 11. This rotary collar 13 has a gear 13b (Fig. 1) on the outer circumferential surface, and is driven and rotated via a pinion (not shown) which engages with this gear 13b. When the rotary collar 13 is driven and rotated, the rotary collar 13 moves in the optical axis direction while rotating following the female screw 13a. On the inner surface at the tip end of the rotary collar 13, rotation transmitting protrusions 13c are formed at intervals

of 120 degrees. Furthermore, on the outer circumferential surface of the rotary collar 13, code plate 14 (RL) (Fig. 1) is fixed in the circumferential direction, and a brush 15 (F) (Fig. 1) which comes into sliding contact with this code plate 14 is fixed to the housing 10. The code plate 14 and brush 15 are provided so as to maintain contact with each other regardless of the moving position of the code plate 14 (rotary collar 13) which advances and retreats in the optical axis direction in accordance with the male screw 11a (female screw 13a) to detect the rotating position of the rotary collar 13 as digital information and (or) analog information. The female screw 13a of the rotary collar 13 is a means for rotatably supporting the rotary collar 13 on the fixed collar 11, and the female screw 13a may support the rotary collar 13 on the fixed collar 11 so that the rotary collar 13 is allowed to only rotate while being restrained from moving in the optical axis direction.

[0018]

The inside of the fixed collar 11 is provided with a coupled member of a rectilinear guide collar 16 (L), a cam collar 17 (RL) which is fitted on the outer circumferential surface of the rectilinear guide collar 16 so that movements in the optical axis direction are restricted and relative rotation is possible,

and a second cam collar 18 (RL) which is fitted on the outer circumference at the tip end of the cam collar 17 so as to rotate in the direction of rotation together with the cam collar 17 and relatively move in the optical axis direction. That is, the rectilinear guide collar 16 has an outward flange 16a at the rear end, and a rectilinear guide ring (flange ring) 19 (L) fixed at the front end via a retainer ring 20 (L). The cam collar 17 is attached and sandwiched between the outward flange 16a and rectilinear guide ring 19, and supported so as to relatively rotate freely from the rectilinear guide collar 16 and move in the optical axis direction together with the rectilinear guide collar 16.

[0019]

The second cam collar 18 fitted on the tip end of the cam collar 17 has rectilinear guide portions 18a which slidably engage with the stopper protrusions 17a formed at intervals of 120 degrees on the outer circumferential surface of the cam collar 17, and the second cam collar is supported so as not to relatively rotate with the cam collar 17, but so as to be relatively movable in the optical axis direction with the cam collar 17. In the vicinities of the stopper protrusions 17a and rectilinear guide portions 18a, compression springs 21 for pressing and moving the second cam collar 18 forward are

inserted, and the second cam collar 18 is normally in contact with the rectilinear guide ring 19. The second cam collar 18 can retreat by a distance corresponding to a clearance in the optical axis direction between the stopper protrusions 17a and rectilinear guide portions 18a while sagging the compression springs 21. The second cam collar 18 can also incline by a clearance in a diameter direction.

[0020]

A male helicoid 17b which screw-fits the female helicoid 11b of the fixed collar 11 is formed on the outer circumferential surface of the cam collar 17, and by cutting a part of the male helicoid 17b off, rotation transmitting grooves 17c into which the rotation transmitting protrusions 13c of the rotary ring 13 fit and which are parallel to the optical axis are formed. On the other hand, on the outward flange 16a of the rectilinear guide collar 16, rectilinear guide protrusions 16b which protrude outward in a diameter direction and fit into the rectilinear guide grooves 11c of the fixed collar 11 are formed at intervals of 120 degrees. Furthermore, in the rectilinear guide collar 16, rectilinear guide through grooves 16c which are at the same positions in the circumferential direction as those of the rectilinear guide protrusions 16b are formed at intervals of 120 degrees so as to penetrate in a direction

parallel to the optical axis.

[0021]

The rectilinear guide through grooves 16c open to the rear end face of the rectilinear guide collar 16, and the outer diameter side thereof is closed by the outward flange 16a and rectilinear guide protrusions 16b. In the outward flange 16a, an insertion groove 16h for a cam follower is formed at the inner diameter side at the same circumferential position as that of the rectilinear guide protrusions 16b.

[0022]

When the coupled member of the rectilinear guide collar 16, cam collar 17, and second cam collar 18 is engaged with the fixed collar 11 and rotary collar 13, the respective rectilinear guide protrusions 16b of the rectilinear guide collar 16 are fitted into the respective rectilinear guide grooves 11c of the fixed collar 11 from an introducing portion 11d, and the respective rotation transmitting protrusions 13c of the rotary collar 13 are fitted into the respective rotation transmitting grooves 17c of the cam collar 17 from an introducing portion 17d, and in this condition, the female helicoid 11b of the fixed collar 11 and the male helicoid 17b of the cam collar 17 are screw-fitted with each other. Furthermore, the male screw 11a of the fixed collar 11 and the

female screw 13a of the rotary collar 13 are screw-fitted with each other.

[0023]

In a condition where assembly has been thus completed as shown in Fig. 2, when the rotary collar 13 is driven and rotated via the gear 13b, the rotary collar 13 advances and retreats in the optical axis direction while rotating due to screw-fitting between the female screw 13a and male screw 11a, and simultaneously, rotation is transmitted to the cam collar 17 and the second cam collar 18 placed on the outer diameter side of the cam collar 17 due to sliding between the rotation transmitting protrusions 13c and rotation transmitting grooves 17c, and movement in the optical axis direction is provided due to screw-fitting between the male helicoid 17b and female helicoid 11b. At this time, the rectilinear guide collar 16 advances and retreats in the optical axis direction without rotating due to sliding between the rectilinear guide protrusions 16b and rectilinear guide grooves 11c, and the cam collar 17 and second cam collar 18 that relatively rotate with respect to the rectilinear guide collar 16 move in the optical axis direction together with the rectilinear guide collar 16.

[0024]

In the inner circumferential surface of the cam collar 17,

first group cam grooves 17C1 and second group cam grooves 17C2 are formed as developed shapes which are shown in Fig. 3. These first groove cam grooves 17C1 and second group cam grooves 17C2 are formed in threes at intervals of 120 degrees in the same shape, and have housing positions, tele end positions, and wide end positions in order from the direction of rotation of the cam collar 17. The rotation angle of the cam collar 17 from the housing position to the wide end position is defined as A.

[0025]

First lens frame 22 (L) holding the first lens group L1 and second lens frame 23 (L) holding the second lens group L2 are guided by the first group cam grooves 17C1, second group cam grooves 17C2, and rectilinear guide through grooves 16c of the rectilinear guide collar 16, and rectilinearly move in the optical axis direction. The first lens frame 22 has three elastic tongue pieces 22b protruding rearward from cylindrical portion 22a at intervals of 120 degrees, and on these elastic tongue pieces 22b, angular protrusions 22c which protrude in a diameter direction and slidably fit in the rectilinear guide through grooves 16c are formed, and on the angular protrusions 22c, follower pins 22d which slidably fit in the rectilinear guide through grooves 16c are planted and fixed. A requirement

for the angular protrusions 22c is that the angular protrusions 22c are protrusions having parallel planes at the contact portions with the rectilinear guide grooves 16c. Lens cylinder 22e fixing the first lens group L1 is coupled with the inner circumferential surface of the cylindrical portion 22a by screw 22f, and by adjusting the screw-fitting position thereof, the position of the first lens group L1 in the optical axis direction within the first lens frame 22 can be adjusted. The lens cylinder 22e is provided with wave washer 22h attached between the lens cylinder and flange 22g of the first lens frame 22, and due to elasticity of the wave washer 22h, the play of the lens cylinder 22e (first lens group L1) in the optical axis direction is eliminated.

[0026]

The second lens frame 23 has three elastic tongue pieces 23b protruding forward from annular portion 23a at intervals of 120 degrees, and on the elastic tongue pieces 23b, angular protrusions 23c which protrude in a diameter direction and slidably fit in the rectilinear guide through grooves 16c are formed, and on the angular protrusions 23c, follower pins 23d projecting in a diameter direction are planted and fixed. The angular protrusions 23c and follower pins 23d are the same as the angular protrusions 22c and follower pins 22d of the first

lens frame 11 except that the direction of the elastic tongue pieces 23b is opposite to the direction of the elastic tongue pieces 22b. The lens cylinder 23e fixing the second lens group L2 is fixed to flange 23g of the second lens frame 23 via fixing screw 23f. To the flange 23g of the second lens frame 23, shutter block 24 is fixed. The shutter block 24 has the function of blocking light fluxes to the CCD 12a when the shutter is released.

[0027]

The abovementioned first lens frame 22 and second lens frame 23 are rectilinearly guided by fitting the respective angular protrusions 22c and angular protrusions 23c in the same corresponding rectilinear guide through grooves 16c of the rectilinear guide collar 16. Then, the follower pins 22d and follower pins 23d project in a diameter direction from the rectilinear guide through grooves 16c of the rectilinear guide collar 16, and fit in the first group cam grooves 17C1 and second group cam groove 17C2 of the cam collar 17 which fits the outer circumference of the rectilinear guide collar 16 in a relatively slidable manner. When the first lens frame 22 and second lens frame 23 are fitted into the rectilinear guide collar 16 and the cam collar 17, the angular protrusions 22c and 23c are fitted into the rectilinear guide through grooves

16c from the rear end surface of the rectilinear guide collar 16, the follower pins 22d and 23d are inserted through the cam follower insertion grooves 16h, and then fitted into the cam grooves 17C1 and 17C2. In Fig. 3, the hatched regions in the contours of the cam grooves 17C1 and 17C2 are used for assembly (follower pins 22d and 23d pass through these regions), and not used during use of the lens barrel.

[0028]

When rotation is provided for the rotary collar 13 by the abovementioned guide structure, the coupled member of the rectilinear guide collar 16, cam collar 17, and second cam collar 18 advances and retreats in the optical axis direction while the cam collar 17 and second cam collar 18 rotates and the rectilinear guide collar 16 does not rotate. As a result, the first lens frame 22 (first lens group L1) and the second lens frame 23 (second lens group L2) rectilinearly move in the optical axis direction by following the cam profiles of the first cam grooves 17C1 and second cam grooves 17C2 while changing the air interval between them, whereby zooming is carried out.

[0029]

Next, the coupled structure of the rectilinear guide ring 19 and retainer ring 20 with the tip end portion of the

rectilinear guide collar 16 are described based on Fig. 6 and Fig. 7. On the rectilinear guide collar 16, three bayonet claws 16d are formed at intervals of 120 degrees at the tip end portion so as to project in a diameter direction, and small-diameter inserting portions 16e are positioned between these bayonet claws 16d. On the back faces of the bayonet claws 16d, small-diameter portions 16f having the same diameter as that of the small-diameter inserting portions 16e are formed, and rotation restricting concavities 16g obtained by notching the small-diameter portions 16f in directions parallel to the axis are formed and positioned at the back surface of the bayonet claws 16d.

[0030]

On the other hand, on the inner circumferential surface of the rectilinear guide ring 19, rotation restricting convexities 19a that are insertable between the bayonet claws 16d from the small-diameter inserting portions 16e, and relatively rotatable with respect to the small-diameter portions 16f after insertion are formed at intervals of 120 degrees. Furthermore, on the outer circumferential surface of the rectilinear guide ring 19, rectilinear guide protrusions 19b whose circumferential positions with respect to the rotation restricting convexities 19a are determined are formed

at intervals of 120 degrees.

[0031]

On the inner circumferential surface of the retainer ring 20, fixing claws 20a that are insertable between the bayonet claws 16d from the small-diameter inserting portions 16e of the rectilinear guide collar 16, and are relatively rotatable with respect to the small-diameter portions 16f after insertion are formed at intervals of 120 degrees. Furthermore, in the front end surfaces, spanner wrench slots 20b for rotary operations are formed.

[0032]

To fix the rectilinear guide ring 19 to the tip end of the rectilinear guide collar 16, the rectilinear guide ring 19 is rotated on the small-diameter portions 16f by fitting the rotation restricting convexities 19a into the small-diameter inserting portions 16e, and the rotation restricting convexities 19a are moved to the back sides of the bayonet claws 16d and fitted into the rotation restricting concavities 16g. By this fitting, the circumferential position of the rectilinear guide ring 19 with respect to the rectilinear guide collar 16 is determined. Next, the retainer ring 20 is rotated on the small-diameter portions 16f by fitting fixing claws 20a into the small-diameter inserting portions 16e, and the

rotation restricting convexities 19a are pressed against the rotation restricting concavities 16g to suppress the movement of the rectilinear guide ring 19 in the axial direction. In this locked condition, the fixing claws 20a enter between the bayonet claws 16d and rotation restricting convexities 19a, and the fixing claws 20a and bayonet claws 16d prevent the rectilinear guide ring 19 from coming-off. Between the rectilinear guide collar 16 and retainer ring 20, irregularity is formed for preventing the retainer ring 20 from rotating in the locked condition (providing a sense of clicking). In Fig. 6, only irregularity 16j at the rectilinear guide collar 16 side is shown.

[0033]

The rectilinear guide protrusions 19b of the rectilinear guide ring 19, which have been thus fixed at the tip end of the rectilinear guide collar 16, are at specific positions (angle relationship) determined in advance with respect to the rectilinear guide protrusions 16b of the rectilinear guide collar 16. The rectilinear guide protrusions 19b are fitted in rectilinear guide grooves 25a that are formed in the inner circumferential surface of outside cylinder (hood cylinder) 25 (L) at intervals of 120 degrees and are parallel to the optical axis, and guide the outside cylinder 25 so that the

outside cylinder 25 is not rotated but can be moved in only the optical axis direction. On the outside cylinder 25, three guide pins 25b are planted and fixed at intervals of 120 degrees, and the guide pins 25b are fitted in the advancing and retreating guide grooves 18b that have been formed at the outer circumferential surface of the second cam collar 18 at intervals of 120 degrees into the same shape as that of the guide pins.

[0034]

The advancing and retreating guide grooves 18b have, as shown in Fig. 8 and Fig. 9, assembly positions at which the guide pins 25b are set for assembly, and housing positions of the cam collar 17, tele end positions, and wide end positions corresponding to the housing positions, tele end positions and wide end positions of the cam collar 17, and in accordance with the rotating position of the second cam collar 18 that rotates together with the cam collar 17, the outside cylinder 25 is advanced and retreated in the optical axis direction. That is, when the guide pins are at the tele end positions for a small angle of view, the outside cylinder 25 is advanced toward the second cam collar 18 (first lens group L1), and when the guide pins are at the tele end positions for a wide angle of view, the outside cylinder is retreated, whereby the outside cylinder

is provided with a function as a lens hood. Fig. 10 shows the position of the outside cylinder 25 at the wide end position, and Fig. 11 shows the position of the outside cylinder 25 at the tele end position.

[0035]

Thus, between the second cam collar 18 which guides the outside cylinder 25 and the cam collar 17 which guides the first lens group L1 and second lens group L2, the compression springs 21 for pressing and moving the second cam collar 18 forward are inserted, when an external force is applied in the direction for pressing the outside cylinder 25 during use, at least a part of the external force can be absorbed by the compression springs 21. That is, the external force compresses the compression springs 21, and then are transmitted from the second cam collar 18 to the cam collar 17, so that a great external force is prevented from applying to the cam collar 17. Therefore, influence on positional accuracy of the first lens group L1 and second lens group L2 can be reduced. More detailed movements and actions of the outside cylinder 25 will be described further with reference to Fig. 12 after a barrier block 27 to be fixed to the tip end of the outside cylinder 22 is described. The reference numeral 29 (F) in Fig. 1 denotes a cover cylinder integrated with the camera body side, inside

of which the outside cylinder 25 advances and retreats.

[0036]

Barrier drive collar 26 is rotatably supported at the inner diameter at the front end of the outside cylinder 25. This barrier drive collar 26 opens and closes the barriers of the barrier block 27 by rotary movements. The barrier block 27 comprises, as shown in Fig. 1 and Fig. 13 through Fig. 15, a decorative panel 27b having photographing aperture 27a, two pairs of barriers 27c and 27d supported on the decorative panel 27b so as to open and close the photographing aperture 27a, a pair of torsion springs 27e which press these barriers 27c and 27d in the direction for closing the photographing aperture 27a, and a barrier presser plate 27f which sandwiches and holds these components with the decorative panel 27b, and the barrier block 27 is assembled in advance as a separate unit. The barriers 27c and 27d are freely rotatable coaxially with common shafts 27g provided on the decorative panel 27b, and the inner barriers 27d are rotatively pressed in the closing directions by the torsion springs 27e latched on the spring latching shaft 27n of the decorative panel 27b. On the barriers 27d, opening and closing protrusions 27h are formed and protruded for opening the barriers 27d against the forces of the torsion springs 27e, and on the barriers 27c, interlocking protrusions

27i which engage with the edge of the barriers 27d and move the barriers 27c in the opening directions together with the barriers 27d to open the barriers 27d are formed. Furthermore, on the opposed surfaces of the barriers 27c and 27d, interlocking protrusions 27j and 27k (Fig. 15) which move the barriers 27c in the closing directions together with the barriers 27d when the barriers 27d move in the closing directions are formed. In the barrier presser plate 27f, exposing holes 27m for projecting the opening and closing protrusions 27h toward the barrier drive collar 26 side are formed.

[0037]

The barrier drive collar 26 is rotatively pressed in the barrier opening direction by tension springs 28 the forces of which are stronger than that of the torsion springs 27e and which are laid between spring latching protrusions 26b formed on the barrier drive collar 26 itself and the spring latching protrusions 25c formed on the outside cylinder 25, and on this barrier drive collar 26, opening and closing dowels 26c which open the barriers 27c and 27d by engaging with the opening and closing protrusions 27h of the barriers 27d are formed. When the barrier drive collar 26 is at the rotation end due to forces of the tension springs 28, the opening and closing dowels 26c

press the opening and closing protrusions 27h, and open the barriers 27d against the forces of the torsion springs 27e, and also open the barriers 27c via the interlocking protrusions 27i (Fig. 15).

[0038]

On the other hand, the barrier drive collar 26 has a rotation transmitting protrusion 26a protruding toward the second cam collar 18 side at a part of the circumferential direction of the barrier drive collar as shown in Fig. 16, and this rotation transmitting protrusion 26a engages with and disengages from a rotation providing concavity 18c formed at the second cam collar 18 (refer to Fig. 8 and Fig. 9 as well). Since the barrier drive collar 26 is supported in a rotatable manner at a fixed position of the outside cylinder 25 in the optical axis direction, when the outside cylinder 25 rectilinearly advances and retreats in the optical axis direction following advancing and retreating guide grooves 18b of the second cam collar 18, as clearly shown in Fig. 8 and Fig. 9, the barrier drive collar 26 comes closer to and separates from the second cam collar 18 that rotates. The rotation transmitting protrusion 26a and rotation providing concavity 18c are formed so that they do not come into contact (engagement) with each other as shown in Fig. 8 at the photographing position (between the tele end

position and wide end position), and during movement from the tele end position to the housing position, the rotation transmitting protrusion 26a and rotation providing concavity 18c engage with each other as shown in Fig. 9 to provide a forcibly rotary force for the barrier drive collar 26 through the rotation providing concavity 18c. When the barrier drive collar 26 rotates to the movement end against the tension springs 28, the opening and closing dowels 26c of the barrier drive collar 26 separate from the opening and closing protrusions 27h of the barriers 27d, and as a result, the barriers 27d are opened by the forces of the torsion springs 27e, the barriers 27c are closed via the interlocking protrusions 27k and 27j, and the photographing aperture 27a closes (Fig. 14). On the other hand, during movement from the housing position to the tele end position, the rotation transmitting protrusion 26a gradually separates from the rotation providing concavity 18c, the barrier drive collar 26 rotates in the barrier opening direction due to the tension springs 28, and as a result, the opening and closing dowels 26c press the opening and closing protrusions 27h, and the barriers 27c and 27d open via the interlocking protrusions 27i. That is, opening and closing of the barriers 27c and 27d is achieved by rotation of the barrier drive collar 26.

Furthermore, a single rotation transmitting projection 26a formed on the barrier drive collar 26 is provided, however, the rotation providing concavity 18c is formed in threes at intervals of 120 degrees, and one of the concavities can be selected when assembling.

[0039]

As mentioned above, the outside cylinder 25 that is guided to be rectilinearly movable in the optical axis direction moves back and forth due to rotation of the second cam collar 18. On the other hand, the first lens group L1 and second lens group L2 move back and forth due to rotation of the cam collar 17. Fig. 12 shows positional changes of the image plane of the CCD 12a, the first lens group L1 and second lens group (the principal point positions), and the barrier block 27 at the tip end of the outside cylinder 25 (photographing aperture 27a of the decorative panel 27b at the tip end of the barrier block). The cam grooves 17C1 and 17C2 of the cam collar 17 and the advancing and retreating cam grooves 18b of the second cam collar 18 are determined so that such movement loci are obtained. The photographing opening is formed to have a roughly rectangular front shape, and Fig. 10 and Fig. 11 show the angles of light flux S that are made incident from the short side direction of the photographing opening 27a, the light flux M

that is made incident from the long side direction, and the light flux L that is made incident from the diagonal direction.

[0040]

The barrier drive collar 26 has a shielding cylinder 26d fixed to the inner diameter portion, which extends to the outer circumference of the tip end of the first lens frame 22 from the barrier drive collar 26. The shielding cylinder 26d has a rotation symmetric shape based on the optical axis, and the shielding function thereof does not change even when the shielding cylinder rotates in a reciprocating manner in response to reciprocating rotation of the barrier drive collar 26.

[0041]

All the abovementioned components comprising the zoom lens barrel are formed of molds of synthetic resin materials except for the springs, feed screws 10e, fixing screws 23f, follower pins 22d and 23d, shutter block 24, and guide pins 25b.

[0042]

In the abovementioned embodiment, the third lens group L3 is set as a focusing lens group, however, another lens group, for example, the first lens group L1 or second lens group L2 may be set as a focusing lens group. In a case where the second lens group L2 is set as a focusing lens group, the shutter block

24 may be provided with a focusing function, and such a shutter block has been generally known.

[0043]

[Description of characteristic portions of the invention]

As aforementioned, the two pairs of barriers 27c and 27d of the barrier block 27 are opened and closed in response to rotary movements of the barrier drive collar 26 to the forward rotation end and rearward rotation end via the outside cylinder 25 (rectilinear cylinder) that is rectilinearly guided. At the photographing position, the rotation transmitting protrusion 26a of the barrier drive collar 26 and the rotation providing concavity 18c of the second cam collar 18 (rotary collar) are not engaged with each other, and the barrier drive collar 26 is held at the rotation end for opening the barriers by the pair of tension springs 28 (drive collar pressing means, opening direction pressing means). At this point, the forces of the pair of torsion springs 27e (barrier pressing means, closing direction pressing means) in the closing directions also act on the barriers 27c and 27d, however, the pressing forces of the tension springs 28 are greater, so that the opening and closing dowels 26c (pressing portions) press the opening and closing protrusions 27h, whereby barriers 27d are opened against the forces of the torsion springs 27e, and the

barriers 27c are also opened via the interlocking protrusions 27i. When the lens barrel moves from the photographing position to the housing position, as shown in Fig. 9, the rotation transmitting protrusion 26a and the rotation providing concavity 18c engage with each other, and a forcibly rotary force in the direction for opening the barriers is provided for the barrier drive collar 26. When the barrier drive collar 26 is rotated to the rotation end against the tension springs 28, the pressing forces acting on the opening and closing protrusions 27h by the opening and closing dowels 26c are released, and the barriers 27c and 27d are closed due to the pressing forces of the torsion springs 27e.

[0044]

Namely, in the barrier opening and closing device of the present embodiment, the forcibly rotary force for rotating the barrier drive collar 26 in the barrier closing direction is provided by the second cam collar 18 as a rotary member that rotates in the same direction as the barrier drive collar 26. As shown in Fig. 8, Fig. 9, and Fig. 16, the rotation providing concavity 18c of the second cam collar 18 and the rotation transmitting protrusion 26a of the barrier drive collar 26 have a rotation providing surface 18d and a rotation transmitting surface 26e, respectively, which are formed in the axial

direction so as to engage with each other, whereby the rotary force of the second cam collar 18 that rotates in the circumferential direction can be transmitted to the barrier drive collar 26 without loss. In a case where the barriers are opened and closed by using the moving forces of the movable members comprising the lens barrel, transmission of the moving forces without loss results in an improvement in operation performance of the barriers without influence on the extending and housing performance of the lens barrel. The reason for this will be described.

[0045]

To rotate the barrier drive collar 26 against the tension springs 28, if the moving forces of the movable members at the motor side are fixed, a structure with a smaller loss in moving forces to be transmitted allows a further increase in the load of the tension springs 28 since the forcibly moving force to be provided for the barrier drive collar 26 increases. The greater the load of the tension springs 28, the stronger the force for opening the barriers. Therefore, in this case, a good response in opening of the barriers and secure a barrier opening operation are guaranteed. For example, the pressing forces of the tension springs 28 in the barrier opening direction act on the opening and closing protrusions 27h that are close to

the axis positions (common shafts 27g) in the barrier 27d, and when foreign matter and dirt are adhered to the tip ends of the barriers 27d distant from the axis positions, if the forces of the tension springs 28 are weak, there is a possibility that the barriers are not securely opened. However, such operation failures can be prevented by increasing the load of the tension springs 28. Furthermore, the load of the torsion springs 27e is determined depending on the relationship with the tension springs 28 (torsion springs 27e < tension springs 28). Therefore, if the load of the tension springs 28 can be increased, the load of the torsion springs 27e can be increased accordingly. For the same reason as in the case of the tension springs 28, when the load of the torsion springs 27e increases, the response in closing of the barriers is improved, and secure a barrier closing operation is guaranteed.

[0046]

Thus, by increasing the load of the springs in the barrier opening and closing device, the barrier operation performance can be improved. On the other hand, if the load of the springs is great, a greater force is required for driving the barriers, however, as in the present embodiment, in a structure in that the moving forces of the movable members comprising the lens barrel are transmitted to the barrier drive collar without loss,

the barrier drive collar can be rotated by the normal lens barrel moving force from the photographing position to the housing position. Therefore, the barriers can be securely driven without losing moving performance of the lens barrel or without an excessive load on the drive source for advancing and retreating the lens barrel.

[0047]

Furthermore, as shown in Fig. 8, when the lens barrel moves from the housing position to the photographing position, the interval in the optical axis direction between the barrier drive collar 26 (outside cylinder 25) and the second cam collar 18 increases, and the rotation transmitting protrusion 26a (rotation transmitting surface 26e) of the barrier drive collar 26 and the rotation providing concavity 18c (rotation providing surface 18d) of the cam collar 18 do not overlap each other in the optical axis direction. The lens barrel of the present embodiment is a zoom lens barrel, and due to necessity of zooming between a tele position and a wide position, the barrier drive collar 26 (outside cylinder 25) and second cam collar 18 relatively rotate at the photographing position. Therefore, as the lens barrel of the present embodiment, it is desirable that the barrier drive collar 26 and the second cam collar 18 are separated in the optical axis direction so as to prevent

the rotation transmitting protrusion 26a protruding toward the axial direction from overlapping with the cam collar 18 in the optical axis direction in order not to prevent relative rotation of the outside cylinder 25 and second cam collar 18.

[0048]

As can be clearly understood from the description above, the barrier opening and closing device of the invention is structured so that the rotary force of the rotary collar is transmitted to the barrier drive collar without loss when the lens barrel moves between the photographing position and housing position, so that the extending and housing performance of the lens barrel itself can be prevented from lowering while improving the barrier operation performance by increasing the load of the pressing means.

[0049]

The present invention has been described in the above based on the illustrated embodiment, however, the invention is not limited to this embodiment. For example, although the lens barrel is described as a zoom lens barrel in the abovementioned embodiment, the present invention can be applied to a lens barrel only if the lens barrel moves between a photographing position and a housing position.

[0050]

In the abovementioned embodiment, the barrier drive collar 26 is pressed in the direction for opening the barriers, and only when the lens barrel is at the housing position, a forcibly moving force is provided in the barrier closing direction by the second cam collar 18 against the pressing forces. The reason for this construction is that continuous engagement between the barrier drive collar 26 and second cam collar 18 when the lens barrel is at the photographing position is not practical in the structure as a zoom lens in which the barrier drive collar 26 and the second cam collar 18 relatively rotate when the lens barrel is at a photographing position between the tele position and wide position, and also relatively move in the optical axis direction. However, in terms of transmission of the moving force of the rotary collar to the barrier drive collar without loss, the relationship between the pressing force of the barrier drive collar and the direction of forcible movement that should be provided by the rotary collar against the pressing direction can be made opposite to the embodiment. Namely, in principle, a structure is possible in that, when the lens barrel is at the housing position, the barrier drive collar and the rotary collar are not engaged with each other, and the barriers are closed by the pressing means for pressing this barrier drive collar, and when the lens barrel moves to

a photographing position, the rotary collar and the barrier drive collar are engaged with each other and forcibly rotated against the pressing means to open the barriers in response to the forcible rotation. In this case, the pressing means for pressing the barriers themselves (corresponding to the torsion springs 27e in the embodiment) may be constructed so as to press the barriers toward the opening positions contrary to the aforementioned embodiment.

[0051]

[Effects of the Invention]

As mentioned above, according to the invention, a barrier opening and closing device which can securely operate lens barriers without losing the operation performance of the lens barrel can be obtained.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1]

A perspective view in a disassembled condition showing the entire structure of the zoom lens barrel according to the invention.

[Fig. 2]

An upper half sectional view in the assembled condition of the same.

[Fig. 3]

A developed view of the cam grooves of the cam collar.

[Fig. 4]

An exploded perspective view showing the relationship between the first lens frame, second lens frame, rectilinear guide collar, and cam collar.

[Fig. 5]

A rear view of the rectilinear guide groove portion of the rectilinear guide collar.

[Fig. 6]

An enlarged and exploded perspective view showing the rectilinear guide collar, rectilinear guide ring, and retainer ring in a disassembled condition.

[Fig. 7]

An enlarged, exploded, and developed view of the same.

[Fig. 8]

A developed view showing the positional relationship of the second cam collar and barrier drive collar in a photographing condition (at the tele end position).

[Fig. 9]

A developed view showing the positional relationship of the same in a housed condition.

[Fig. 10]

An upper half sectional view showing the positional

relationship between the outside cylinder and second cam collar (first lens group) in a wide photographing condition.

[Fig. 11]

An upper half sectional view showing the positional relationship between the outside cylinder and second cam collar (first lens group) in a tele photographing condition.

[Fig. 12]

An upper half sectional view showing the positional relationship between the outside cylinder and second cam collar (first lens group) in a tele photographing condition by solid lines, and showing the same in a wide photographing condition by dotted lines.

[Fig. 13]

An exploded perspective view of the barrier block viewed from the rear side.

[Fig. 14]

A perspective view of the barrier block in an assembled condition excluding the barrier presser plate viewed from the rear side.

[Fig. 15]

A front view showing the barrier opening and closing conditions of the barrier block.

[Fig. 16]

An exploded perspective view showing the relationship between the rotation providing concavity of the second cam collar and the rotation transmitting protrusion of the barrier drive collar.

[Fig. 17]

A front view of the barrier drive collar rotatably supported on the outside cylinder at one (barrier closing position) of the rotary ends.

[Fig. 18]

A front view of the same barrier drive collar at the other rotary end (barrier opening position).

[Description of Symbols]

L1 first lens group

L2 second lens group

L3 third lens group

10 housing

11 fixed collar

11a male screw

11b female helicoid

11c rectilinear guide groove

12 substrate

12a CCD

13 rotary collar

13a female screw
13b gear
13c rotation transmitting protrusion
14 code plate
15 brush
16 rectilinear guide collar
16a outward flange
16b rectilinear guide protrusion
16c rectilinear guide through groove
16d bayonet claw
16e small-diameter inserting portion
16f small-diameter portion
16g rotation restricting concavity
16h cam follower inserting groove
17 cam collar
17a stopper protrusion
17b male helicoid
17c rotation transmitting groove
17d introducing portion
18 second cam collar (rotary collar)
18a rectilinear guide portion
18b advancing and retreating guide groove
18c rotation providing concavity

18d rotation providing surface
19 rectilinear guide ring
19a rotation restricting convexity
19b rectilinear guide protrusion
20 retainer ring
20a fixing claw
20b spanner wrench slot
21 compression spring
22 first lens frame
22a cylindrical portion
22b elastic tongue piece
22c angular protrusion (parallel plane protrusion)
22d follower pin
22f screw
22g flange
22h wave washer
23 second lens frame
23a annular portion
23b elastic tongue piece
23c angular protrusion (parallel plane protrusion)
23d follower pin
23e lens cylinder
23f fixing screw

23g flange
24 shutter block
25 outside cylinder (rectilinear cylinder)
25a rectilinear guide groove
25b guide pin
25c spring latching protrusion
26 barrier drive collar
26a rotation transmitting protrusion
26b spring latching protrusion
26c opening and closing dowel (pressing portion)
26d shielding cylinder
26e rotation transmitting surface
27 barrier block
27a photographing aperture
27b decorative panel
27c, 27d barrier
27e torsion spring (barrier pressing means, closing direction
pressing means)
27f barrier presser plate
27g common shaft
27h opening and closing protrusion
27i, 27j, 27k opening and closing protrusion
28 tension spring (drive collar pressing means, opening

direction pressing means)

29 fixed cover cylinder

[TITLE OF DOCUMENT] Abstract

[ABSTRACT]

[OBJECT] To obtain a barrier opening and closing device which can securely operate lens barriers without losing operation performance of a lens barrel.

[COMPOSITION] A barrier opening and closing device for a lens barrel, which is provided on a lens barrel that is movable to a photographing position and a housing position at which photographing is not carried out, and closes the photographing aperture ahead of the photographing lens by barriers when the lens barrel is at the housing position, and opens the barriers when the lens barrel is at the photographing position, comprises: a barrier drive collar for opening and closing said barriers by forward and backward rotations; a drive collar pressing means for pressing this barrier drive collar forward or in reverse; a rotary collar which at least rotates when the lens barrel moves between the photographing position and housing position; and a rotation providing surface and a rotation transmitting surface which are formed at the barrier drive collar and rotary collar in the axial direction and engages with each other when the lens barrel moves to either the photographing position or housing position, and forcibly rotates the barrier drive collar together with the rotary

collar in a direction opposite to said drive collar pressing means.

[SELECTIVE DRAWING] Fig. 16

Fig.1

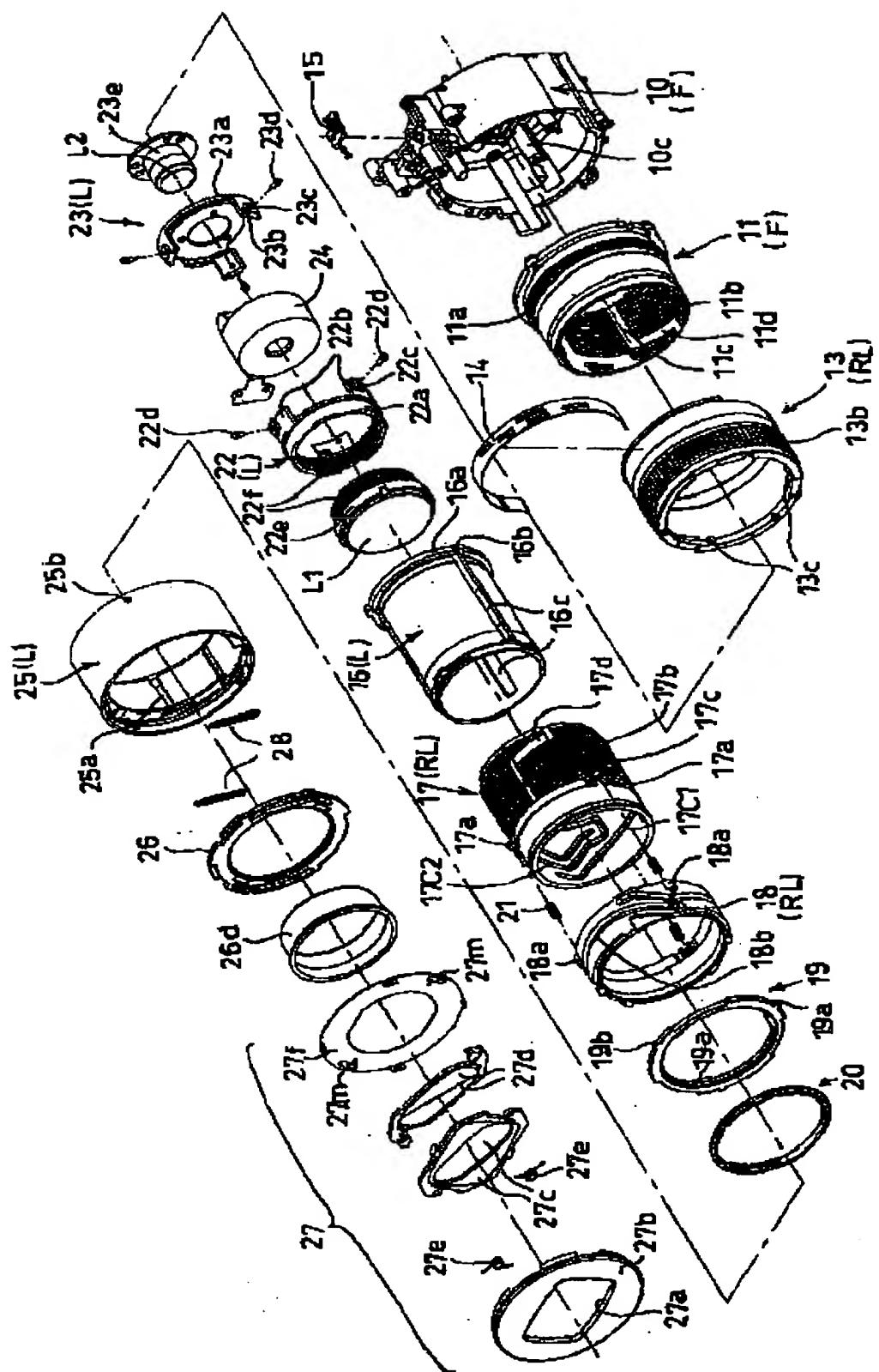


Fig.2

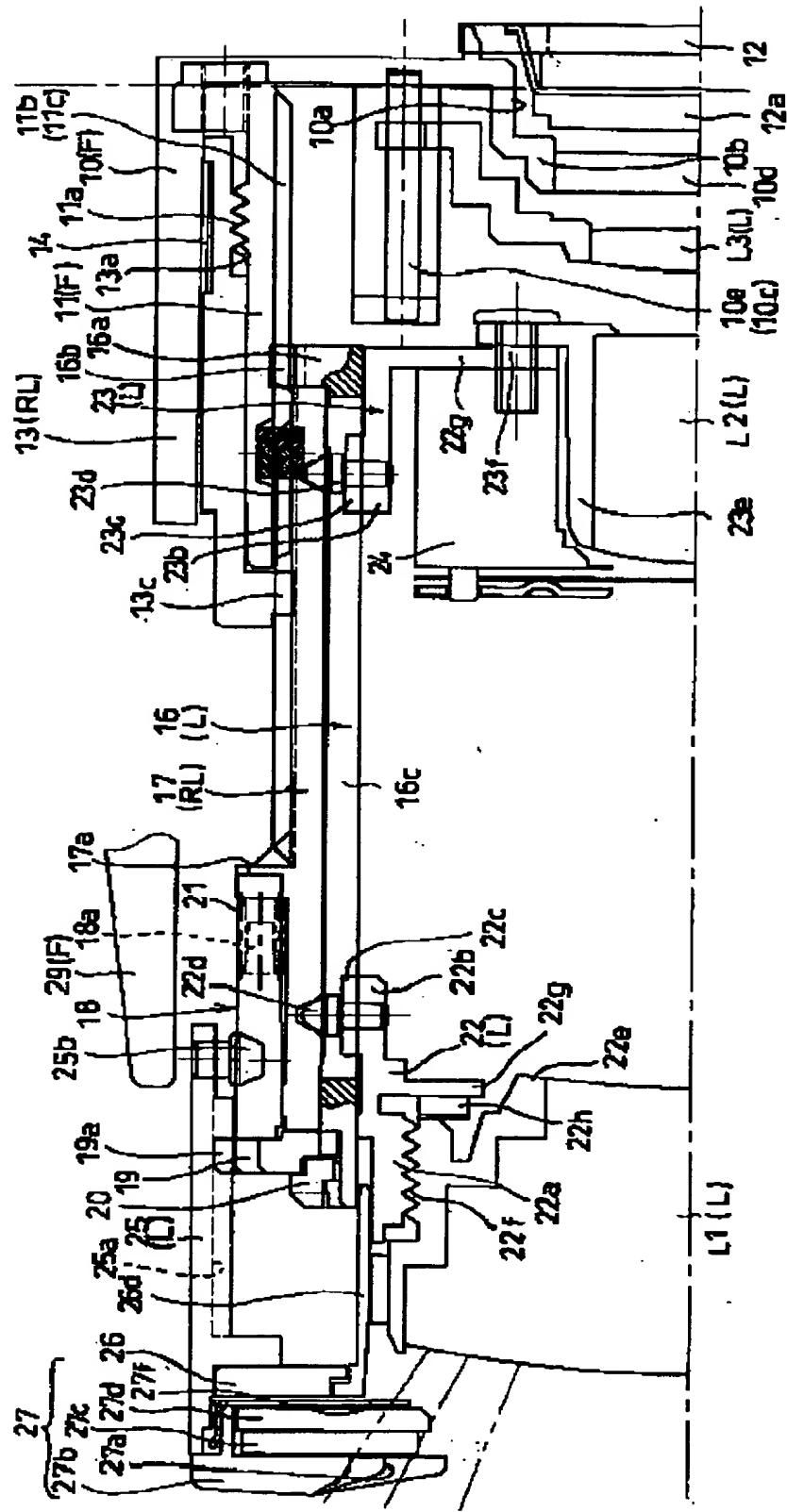


Fig.3

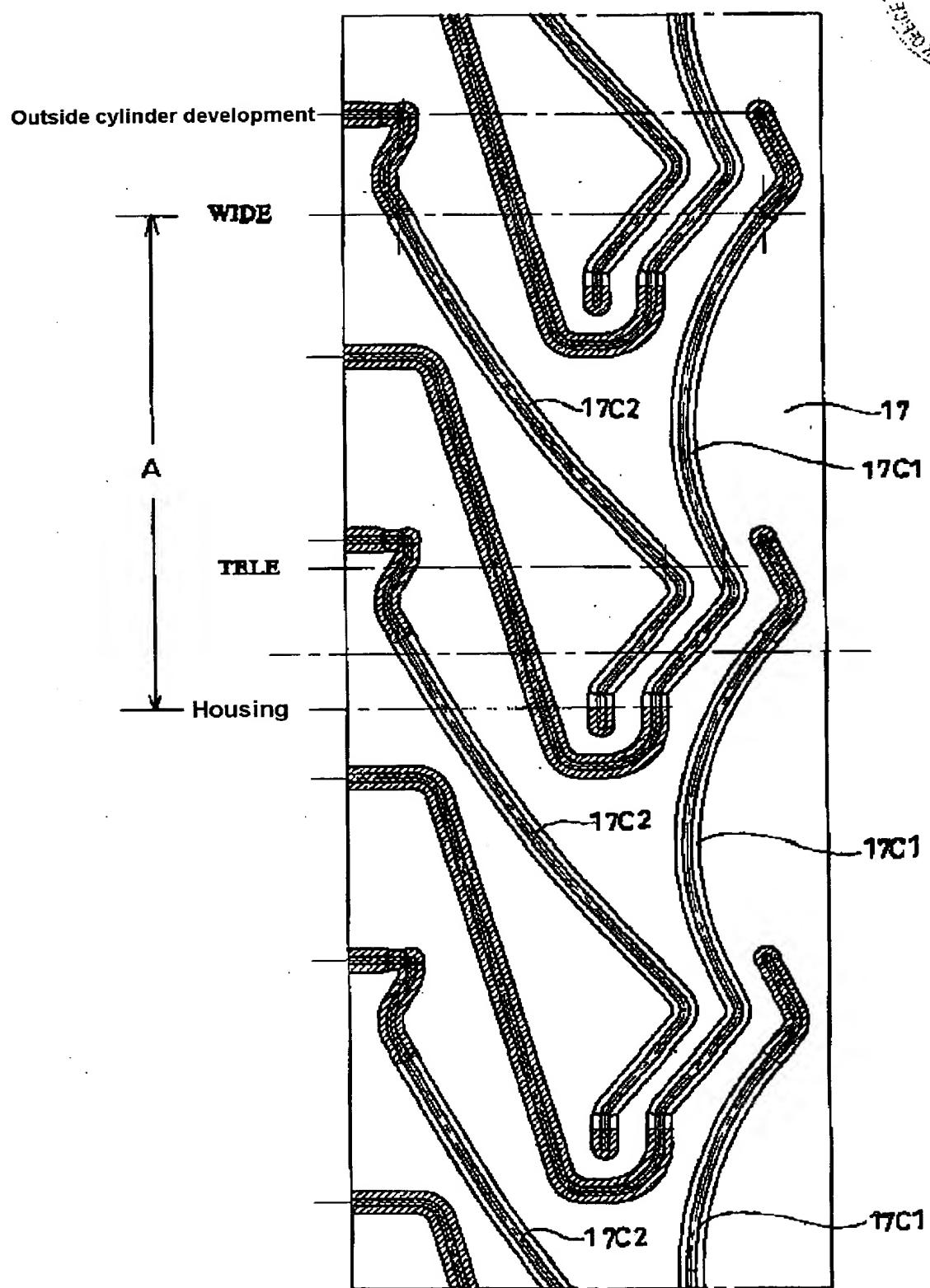


Fig.4

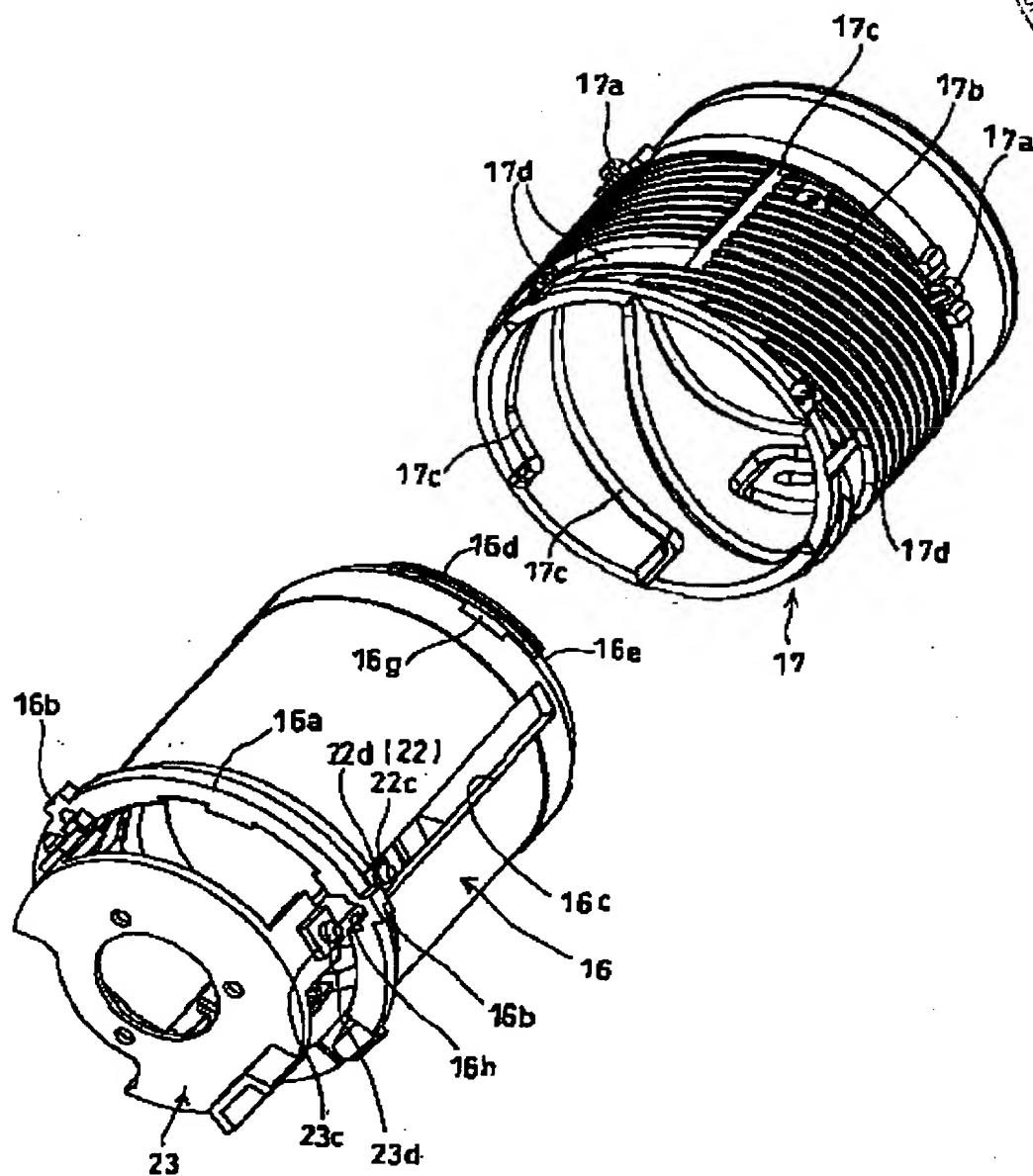


Fig.5

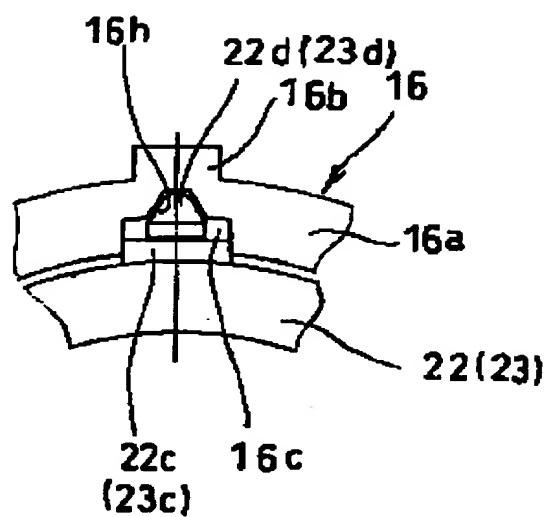


Fig.6

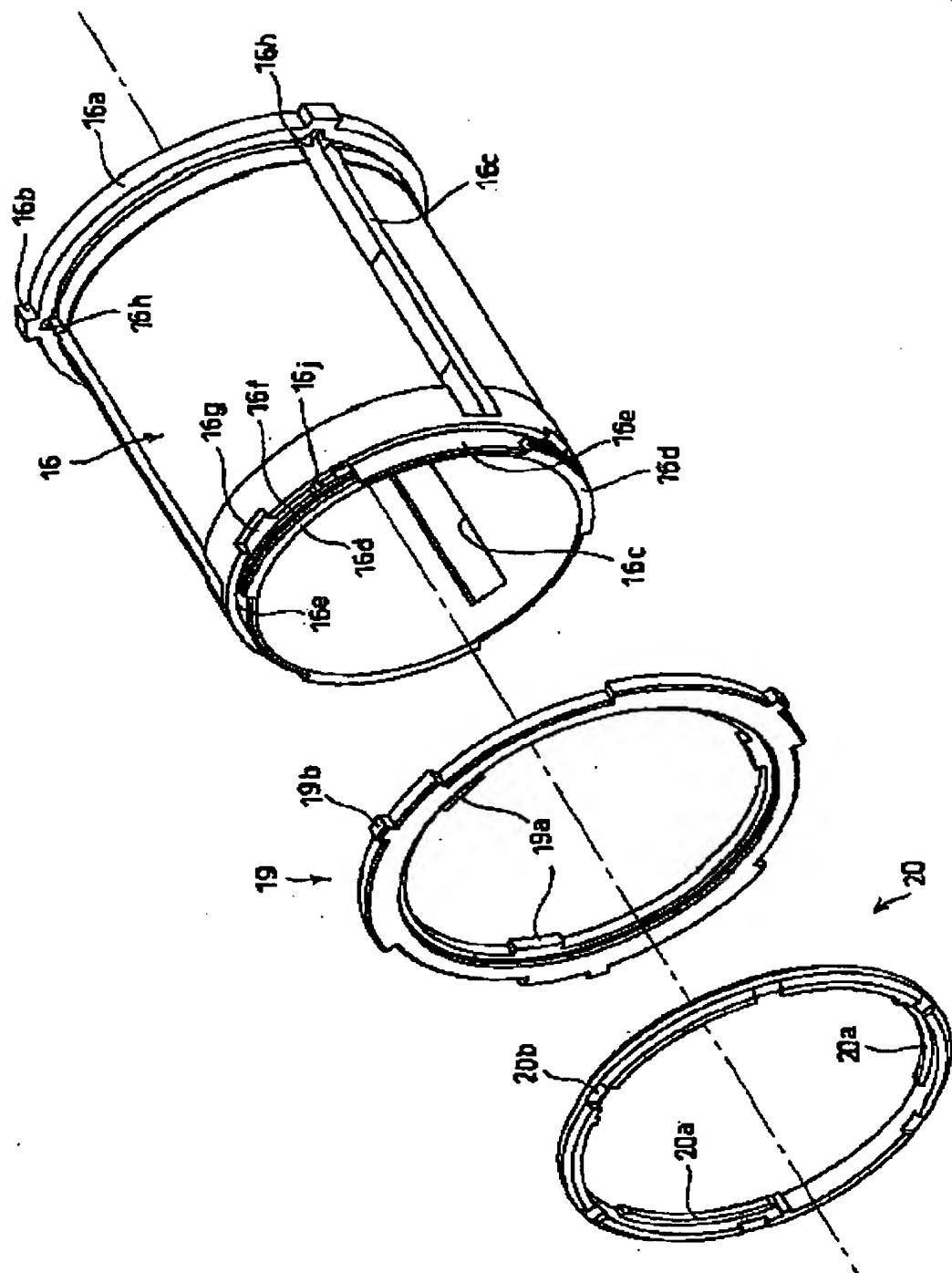


Fig.7

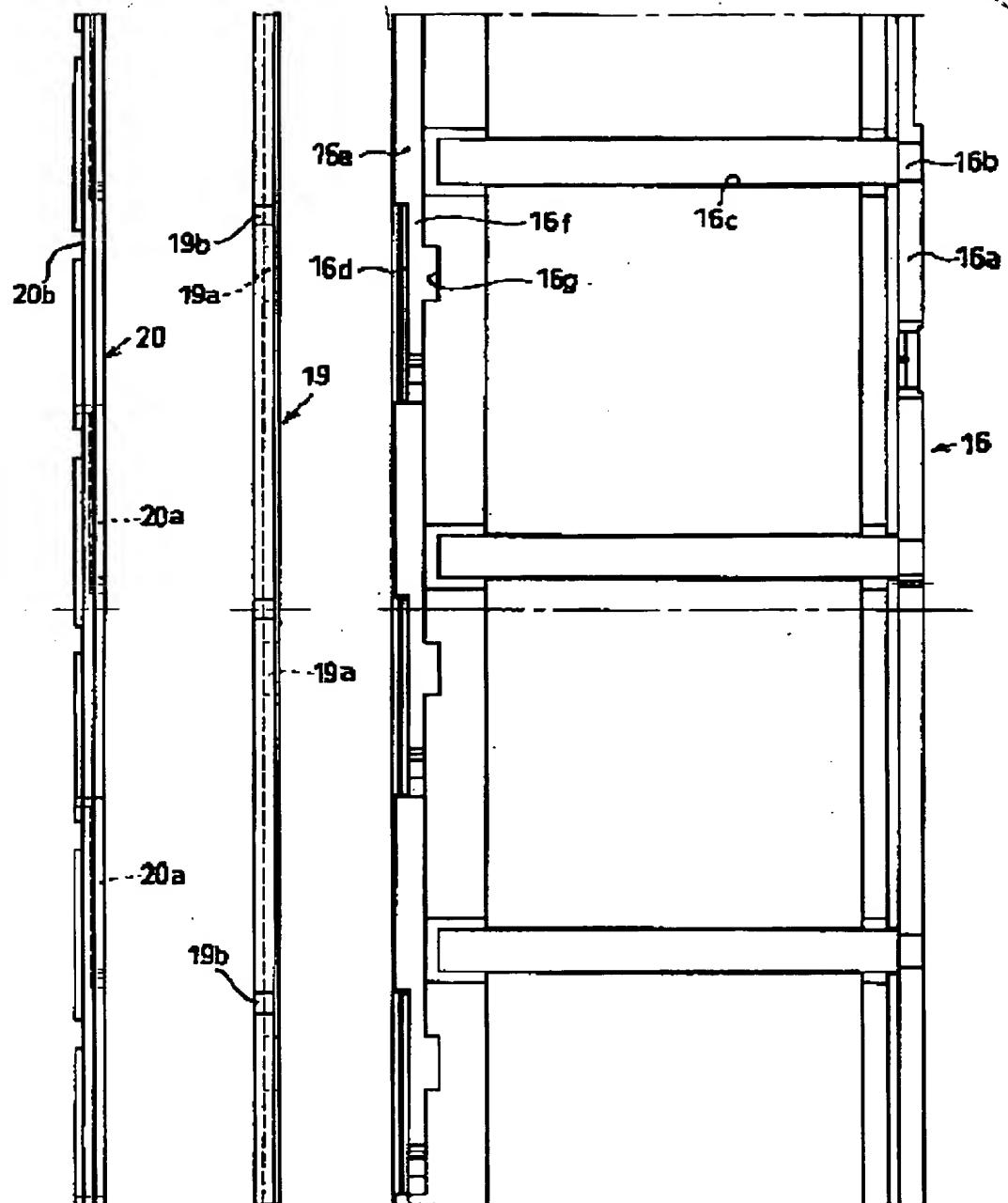


Fig.8

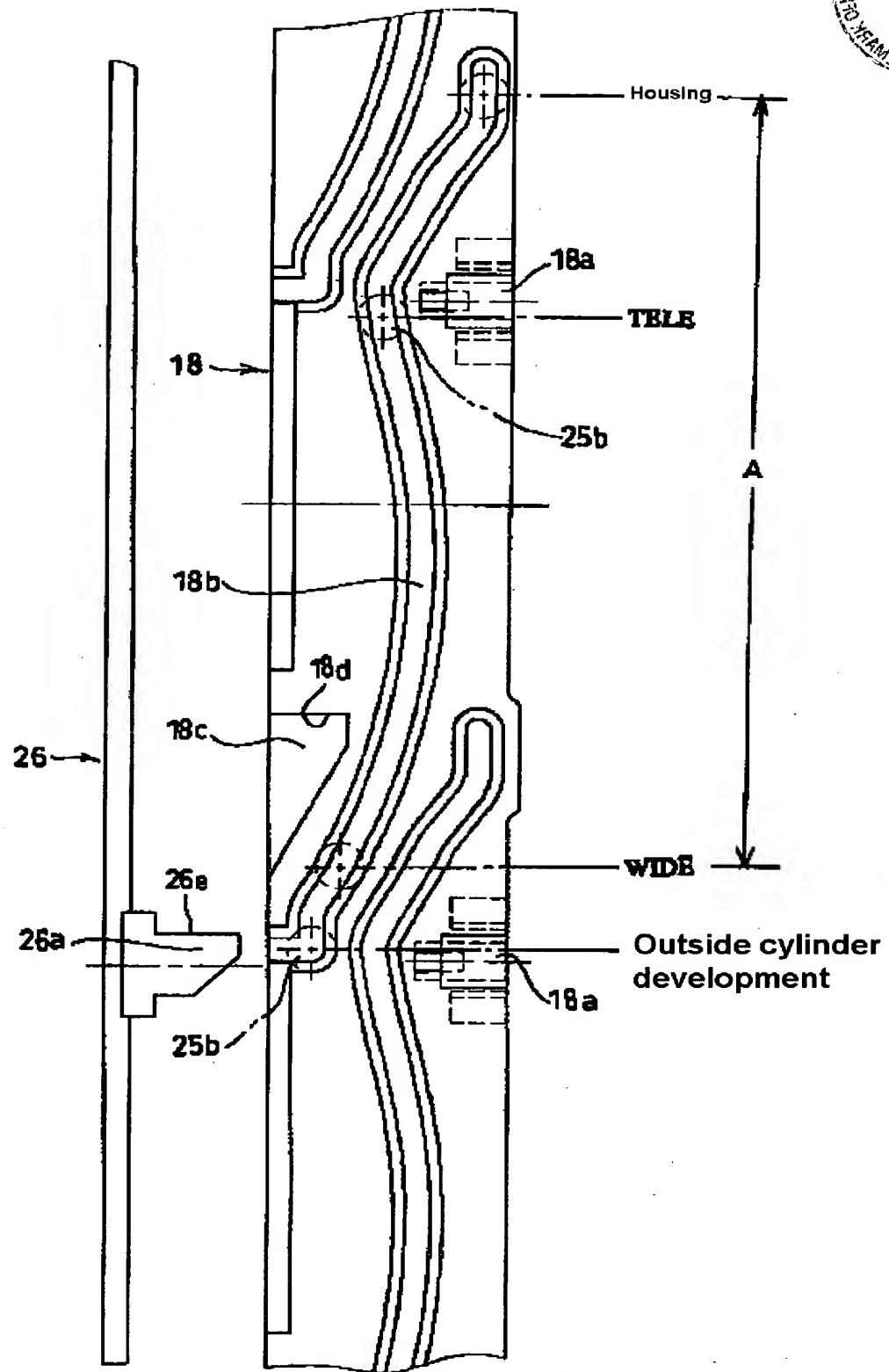


Fig.9

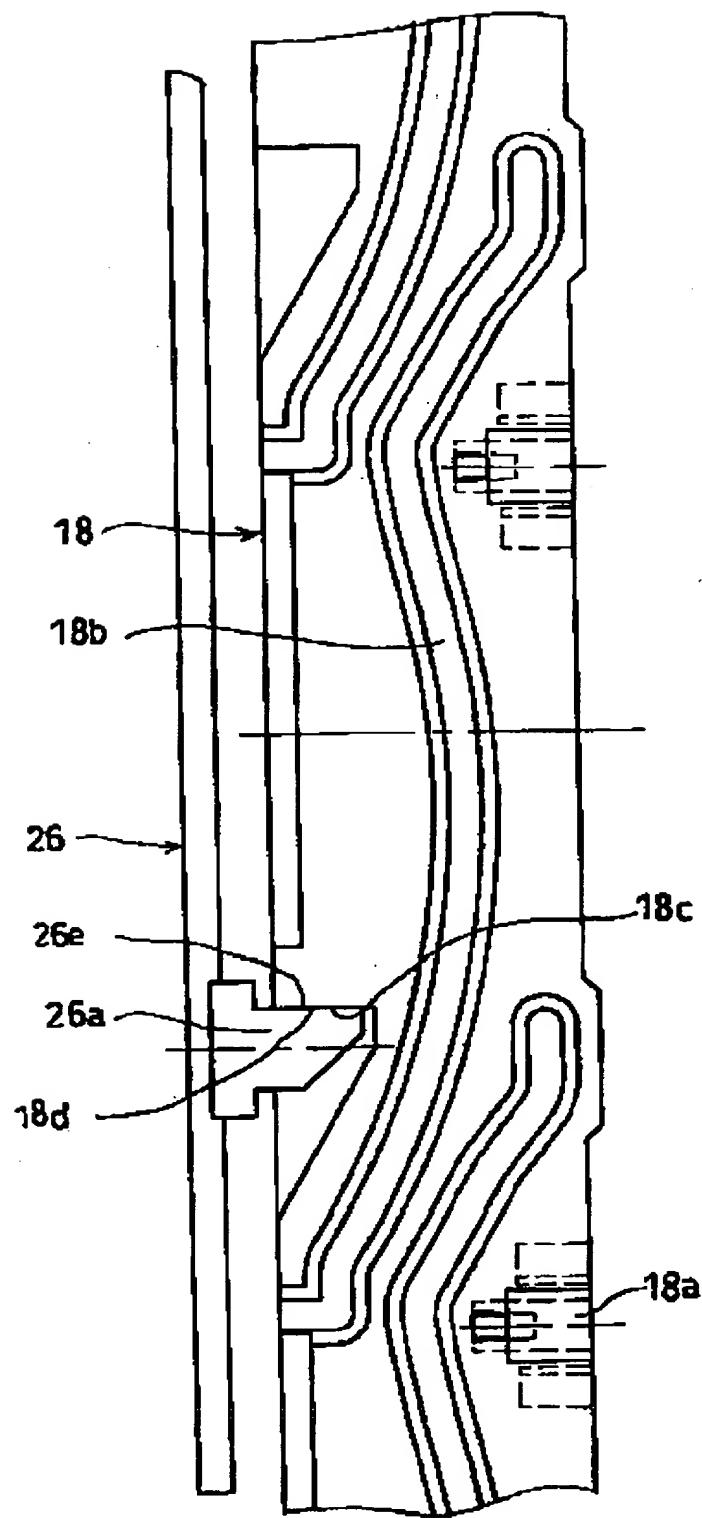


Fig.10

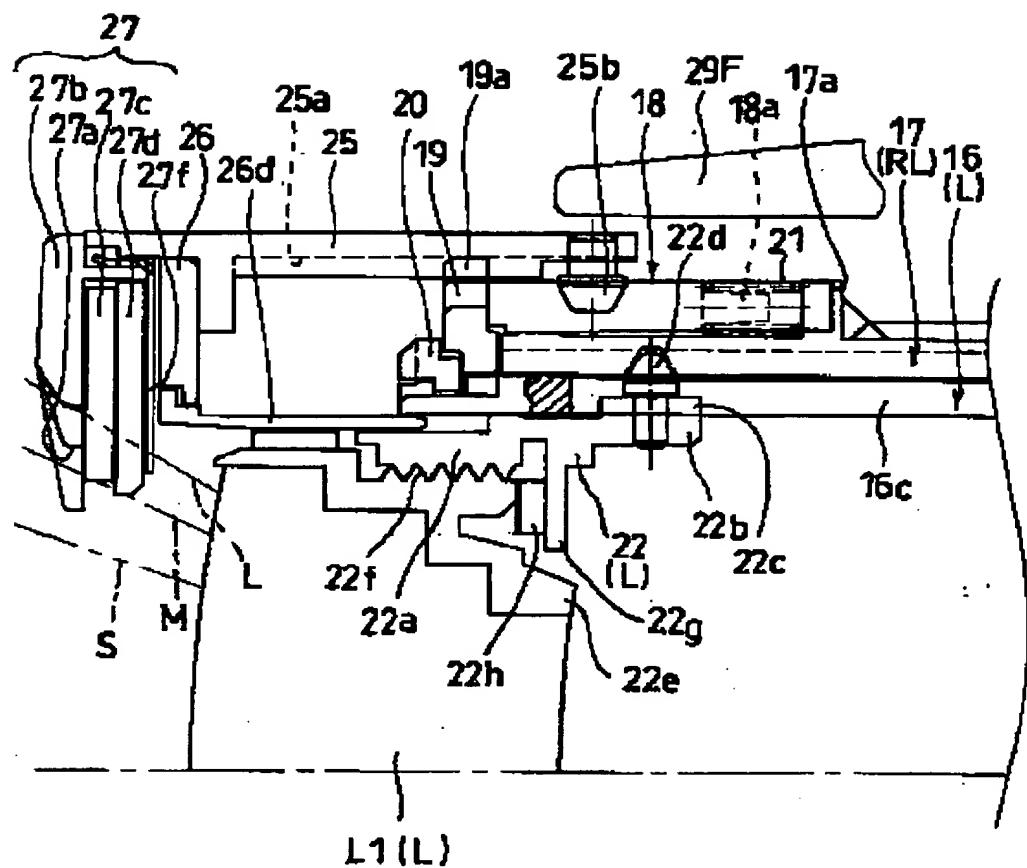


Fig.11

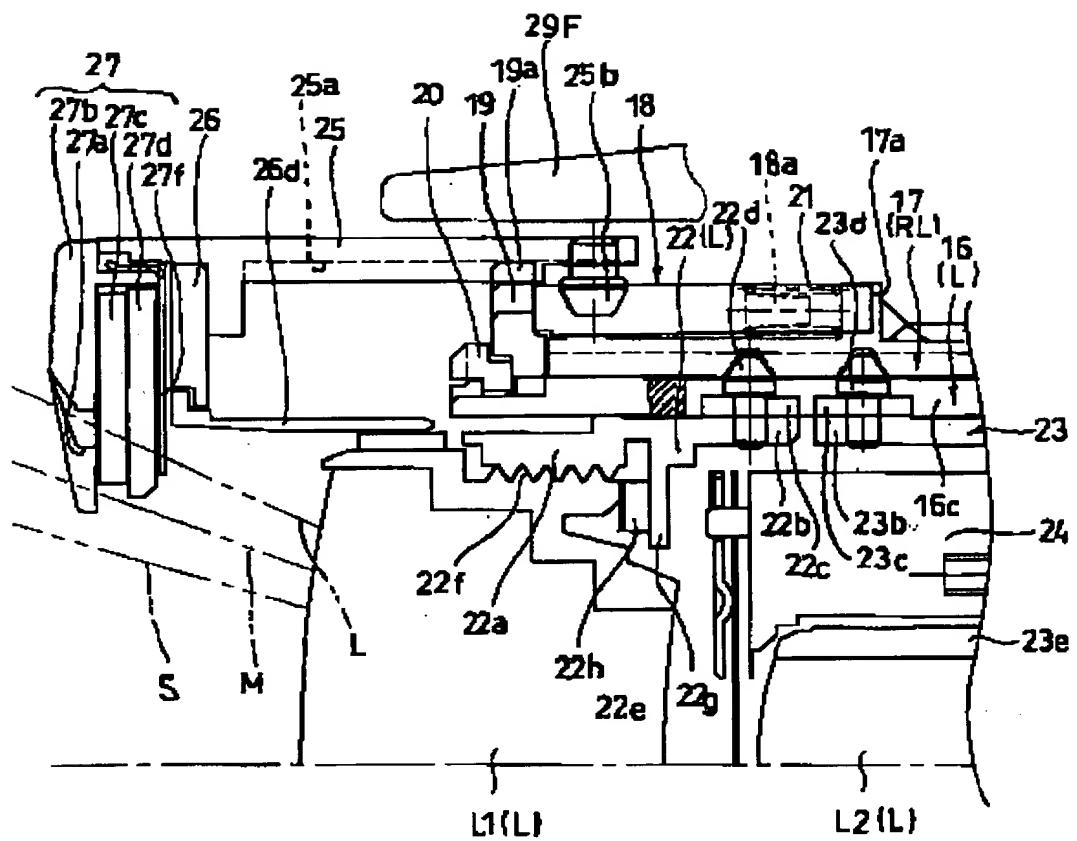


Fig.12

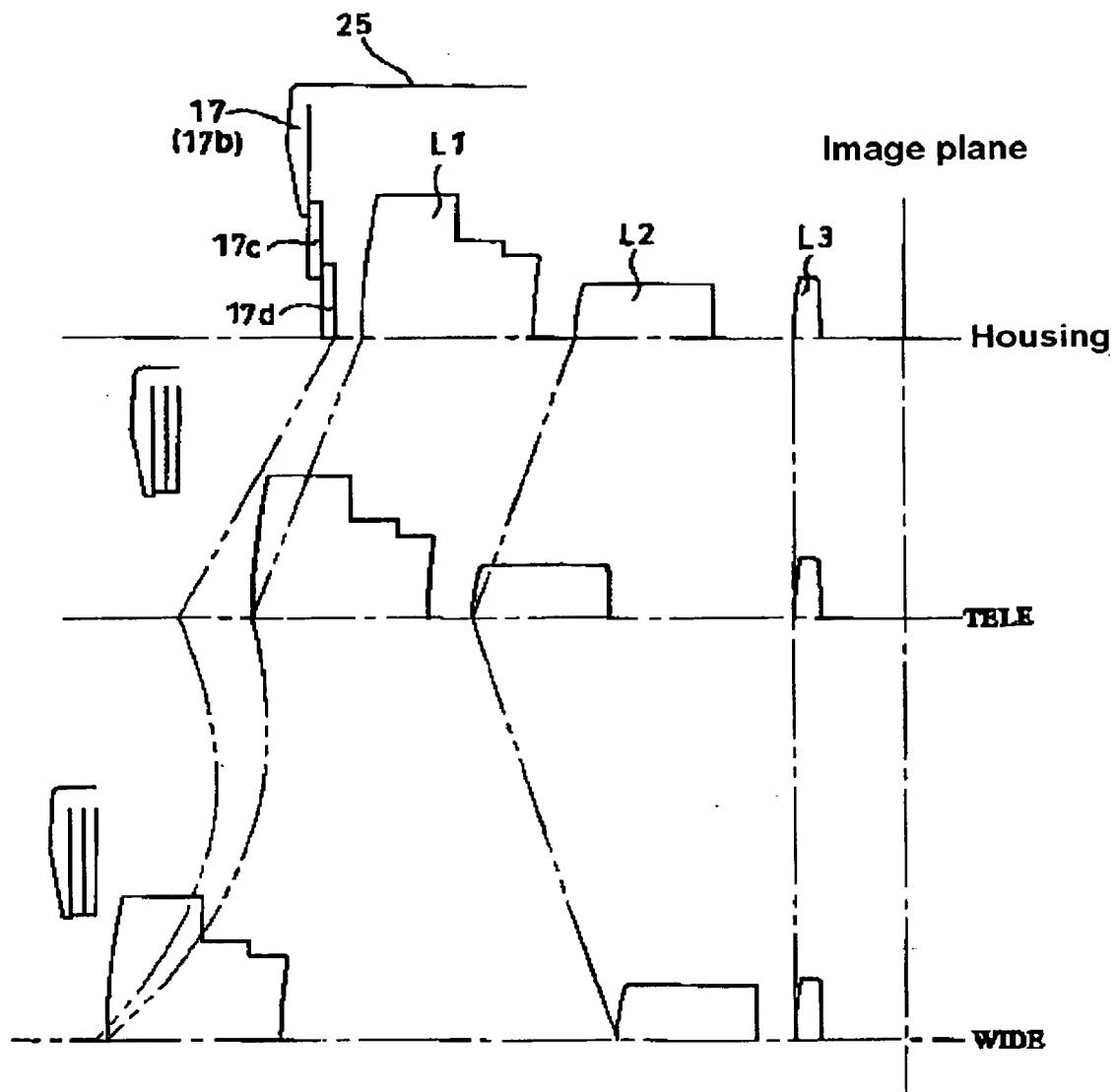


Fig.13

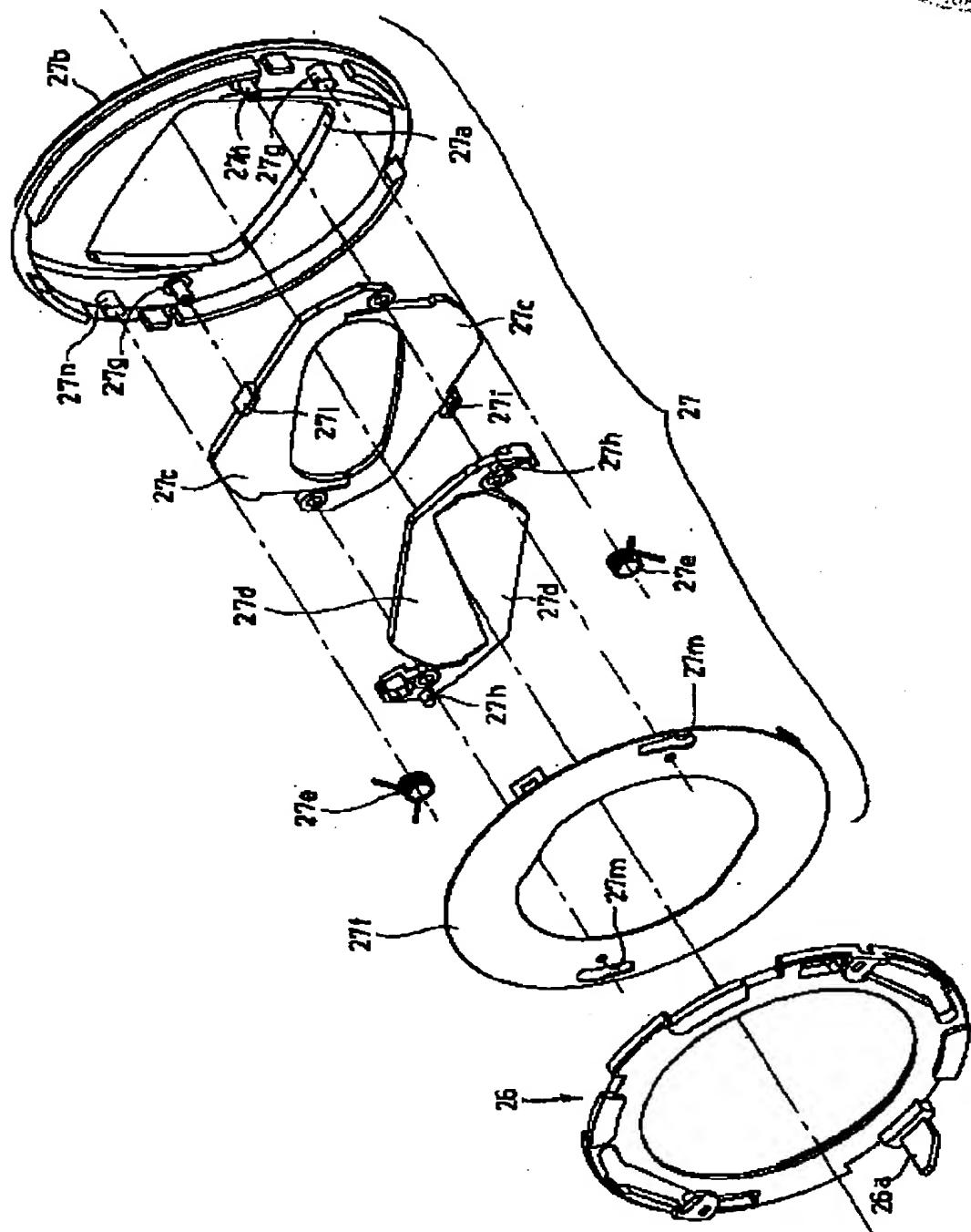


Fig.14

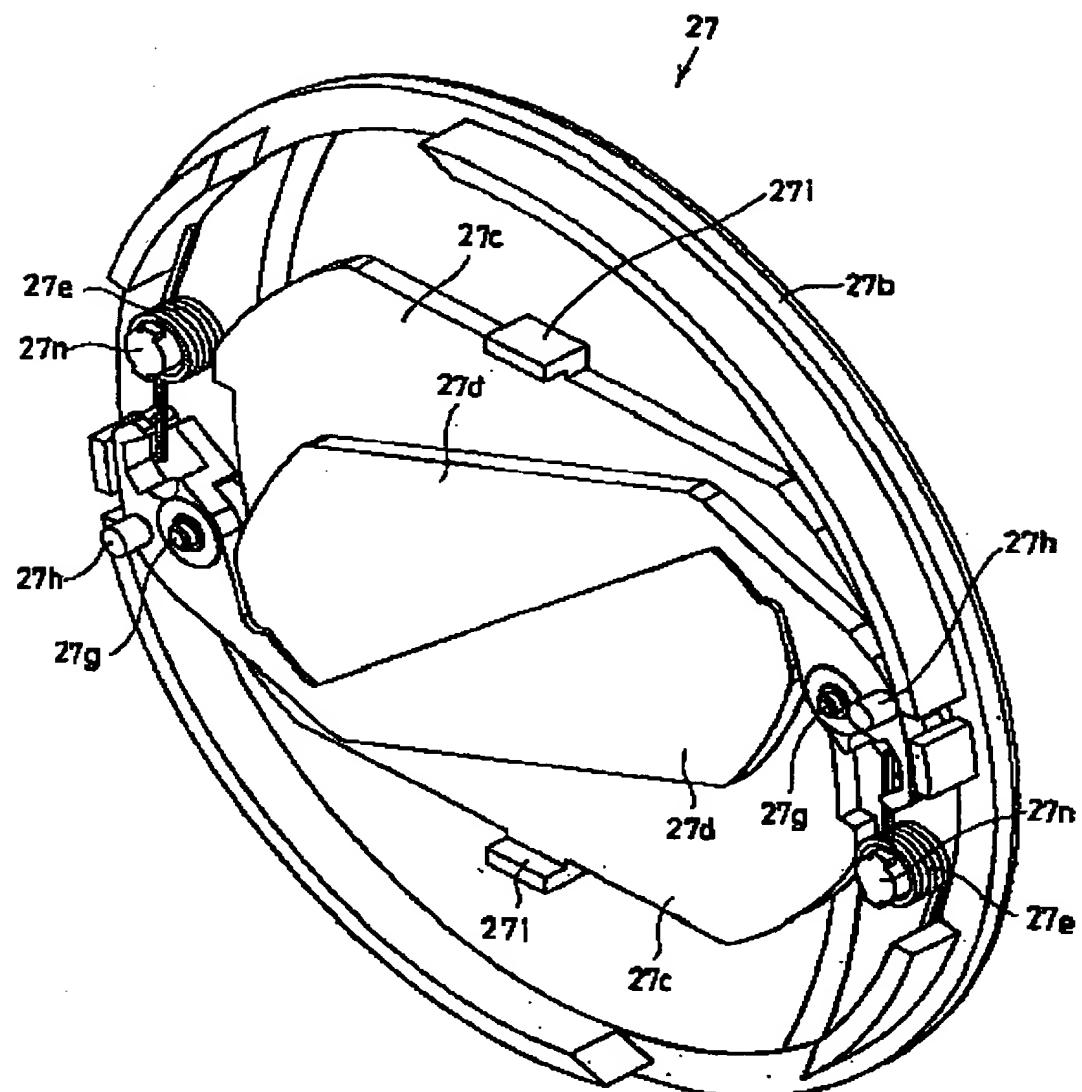


Fig.15

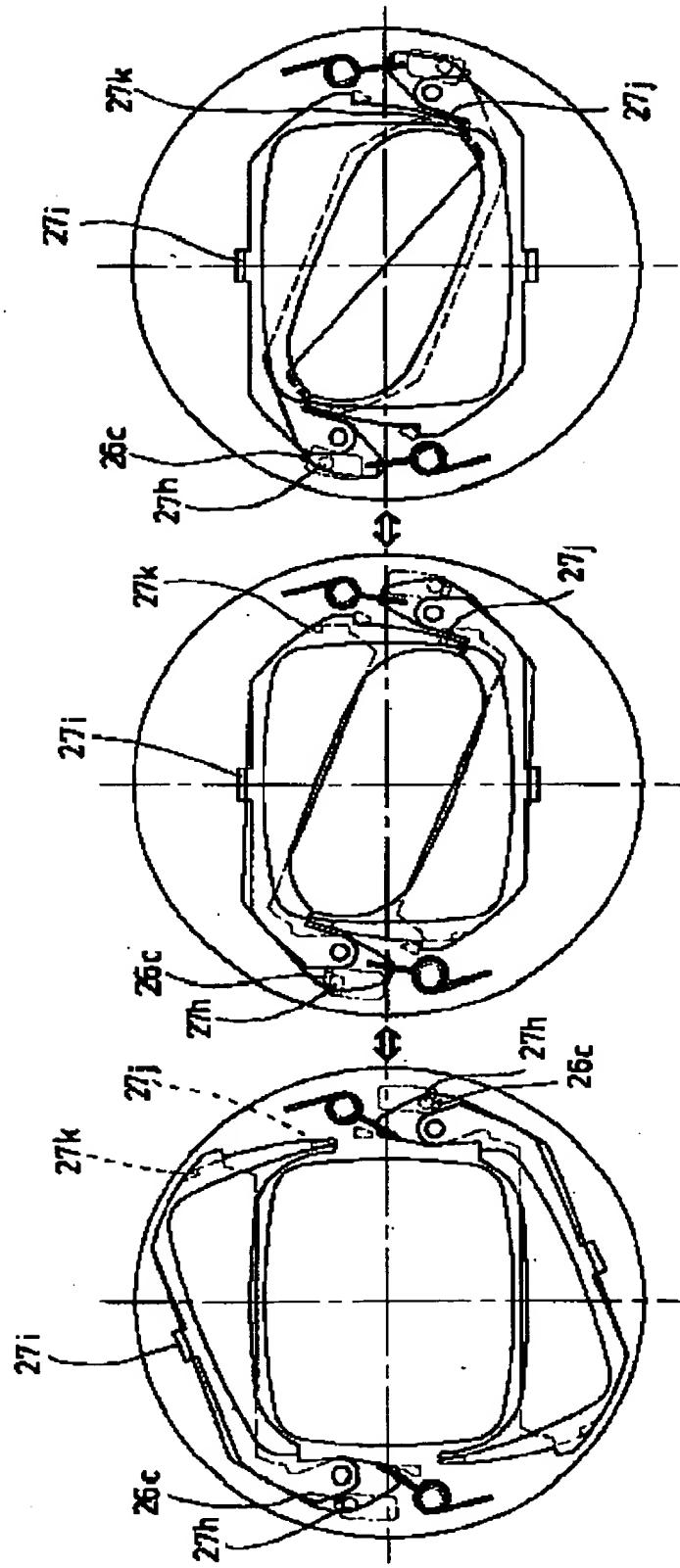


Fig.16

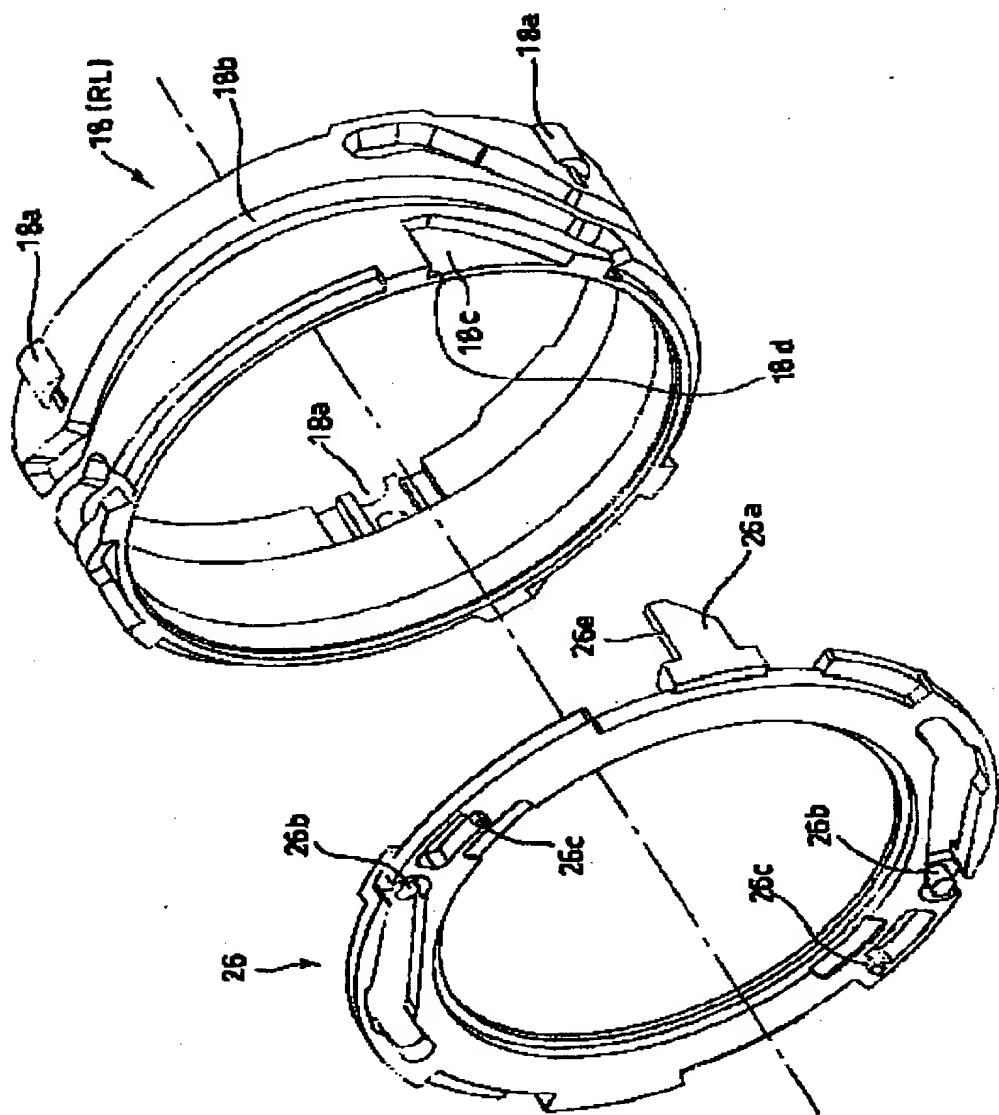


Fig.17

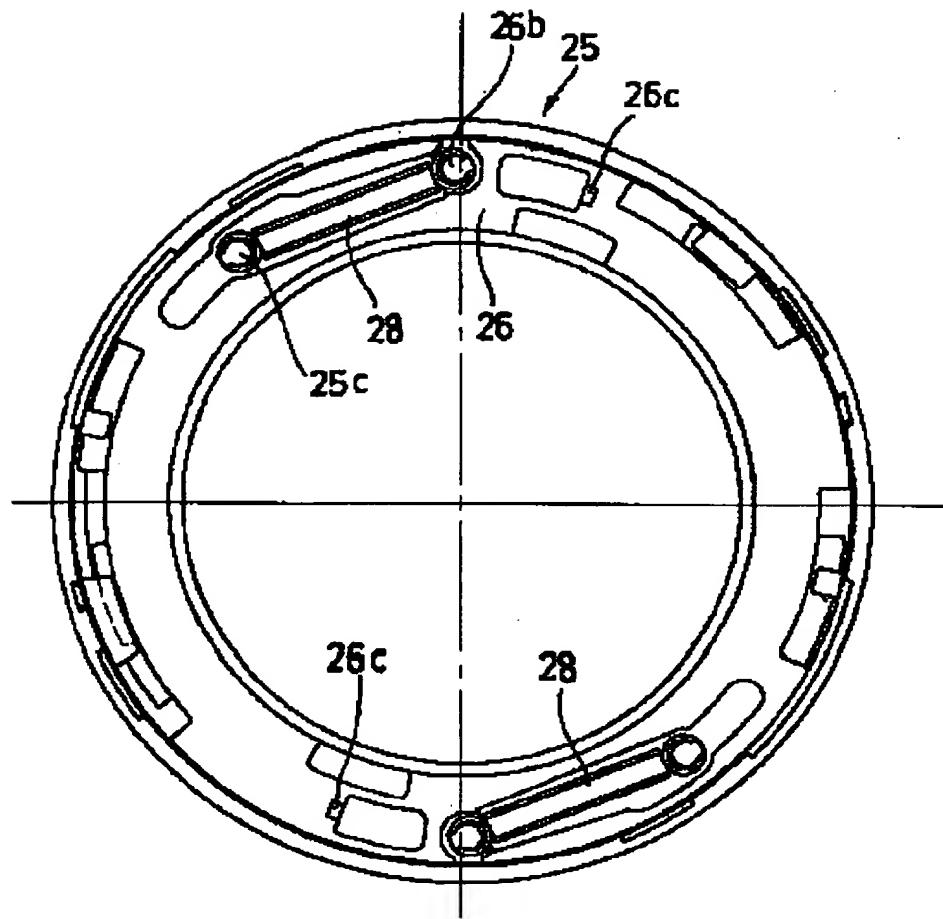


Fig.18

